SURFACE CHEMISTRY AND ELECTROCHEMICAL PROPERTIES OF FUNCTIONALIZED ULTRANANOCRYSTALLINE DIAMOND THIN-FILMS*

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Abstract

The surface properties of ultrananocrystalline diamond (UNCD) thin-films, which include low friction coefficients, extreme chemical and biological inertness, and superb electrochemical properties, depend strongly on the UNCD surface chemical compositions. The control and manipulation of the surface chemistry of UNCD is essential in tailoring its surface properties for specific applications such as hard wear coatings, cold-cathode electron sources, biomedical implants, and chemical and biological sensors. Accordingly, we have developed different strategies for surface functionalization and interfacial engineering of UNCD thin films. Oxygen or ammonia plasma treatment allows for the introduction of oxygen or nitrogen containing functionalities to the H-terminated UNCD surfaces. Electrochemical reduction of diazonium salts is also used to introduce different aryl derivatives onto UNCD surface, which enables the control over UNCD surface charges and surface hydrophobicity. The surface morphology and chemistry of the chemically modified UNCD films were fully characterized using atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), and contact angle measurements. Cyclic voltammetry (CV) and ac impedance spectroscopy were employed to probe the charge transfer kinetics at the modified electrode/electrolyte interface. The attached organic adlayer also served as a linker for the subsequent coupling of a variety of biomolecules. We have demonstrated that covalent immobilization of redox active enzymes (e.g. glucose oxidase) onto UNCD surface could be achieved via the surface tethered amino or carboxyl functionalities. Fluorescence microscopy and electrochemical measurements were used to validate the biological functionalization and the enzymatic activities of the tethered biomolecules. The potential of UNCD based bio/organic-inorganic interfaces for biomedical implants and electrochemical biosensing applications will also be discussed. *This work was supported by the U.S. Department of Energy, BES-Materials Sciences, under Contract No. W-13-109-ENG-38.

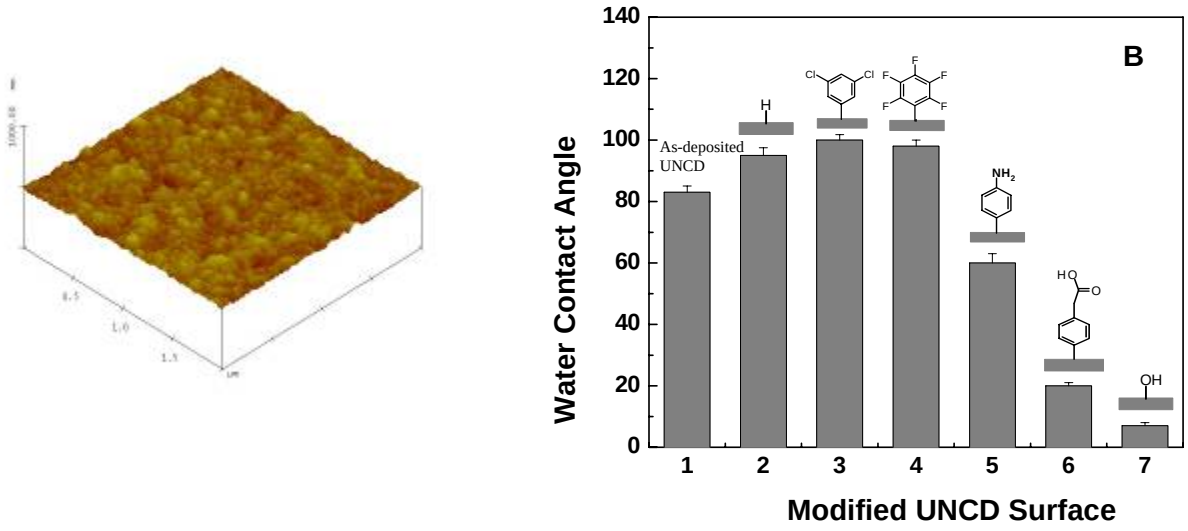

Figure 1. (A) AFM image of a dichlorophenyl-modified UNCD surface. (B) Static contact angle measurements of bare and modified UNCD surfaces.

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